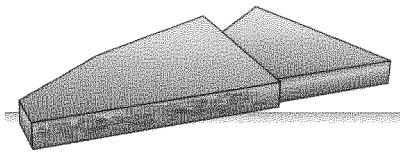

7. SUMMARY AND CONCLUSIONS OF THE ANCILLARY BASIS FOR RISK ANALYSIS

Estimated cumulative human health arid ecological risks associated with the SDA are presented in this ABRA in support of the future development of the comprehensive RI/FS for WAG 7. The comprehensive RI/FS for WAG 7 at the INEEL is identified in the FFA/CO as OU 7-13/14 (DOE-ID 1991). A binding agreement between DOE, IDEQ, and EPA, the FFA/CO governs CERCLA activities at the INEEL, including remedial decision making for areas at the INEEL that pose unacceptable risk to human health or the environment. Waste Area Group 7 is the designation in the FFA/CO for the collective facilities at the RWMC, including the SDA, the TSA, and the adjacent administration and operations areas. The analysis in this report focuses solely on the SDA. The ABRA and conclusions are summarized below.

7.1 Summary

Estimates of cumulative human health risks and ecological risks associated with WAG 7 are presented in this ABRA. Analysis focuses on landfilled waste in the SDA. Because of ongoing operations at TSA, evaluating residual contamination at the TSA has been deferred until future closure of tlie facility. The TSA operations will be closed under RCRA, with any residual contamination to be addressed under CERCLA (DOE-ID 1998).

Evaluation of risk is typically an iterative process, with each iteration providing an increasingly refined assessment. This ABRA is a continuation and update of the WAG 7 risk evaluation that was presented in the IRA (Becker et al. 1998). The same models as thase used in the IRA, with some improvements, were implemented to estimate current and future concentrations of COPCs in environmental media used to estimate risk.

The fundamental framework for preparation of the ABRA is provided in the first three sections of this report. Much information was taken from the IRA and updated to reflect additional information developed over the past few years. The regulatory setting for this ABRA and the physical setting for the site are described in Sections 1 and 2. Past RWMC operations, historical background, and other information used to characterize the risk and form a basis for the future analysis of remedial alternatives are presented in Section 3.

Sections 4 through 6 build on the fundamental framework presented in the first three sections to estimate potential human health and ecological risks associated with the SDA. The current knowledge about contaminant inventories and waste buried in the SDA is presented in Section 4, which evaluates the nature and extent of environmental contamination based on detected concentrations at WAG 7. The development, implementation, and results of modeling to estimate media concentrations over time are discussed in Section 5. Estimated media concentrations produced by the modeling are used in Section 6 to characterize risk in the context of human health and ecological conceptual site models. Information in Sections 4, 5, and 6, summarized below, is critical to plan ongoing work to support future remedial decisions for WAG 7.

7.1.1 Nature and Extent of Contamination

The nature and extent of contamination associated with the SDA are evaluated in Section 4 for all environmental media. The human health contaminant screening in the IRA (Becker et al. 1998) and the revised ecological contaminant screening (Hampton and Becker 2000) were used to identify contaminants for evaluation. The final human health COPC list in the IRA contained 20 radionuclides and four chemical contaminants. Monitoring data indicate that some COPCs occur in low concentrations in the vadose zone and aquifer and are likely attributable to waste buried in the SDA.

Evaluation of the nature and extent of contamination concludes that low concentrations of carbon tetrachloride, nitrates, and C-14 are affecting the aquifer near the SDA. Carbon tetrachloride has been detected slightly above the MCL and nitrate levels near the southeast comer of the SDA are slowly but steadily increasing. Low concentrations of C-14 also have been detected in the region.

Several other contaminants buried in the SDA have not impacted groundwater quality, but have been detected at low concentrations in the vadose zone and may be migrating. Most vadose zone detections are in the interval above the B-C interbed. Some contaminants have been detected at deeper intervals above the C-D interbed. Highest densities of detections occur in the region beneath Pit 5 and Pad A and in the perched water well near the west end of Pit 4 in the SDA. The most frequently detected contaminants in the vadose zone are nitrates, carbon tetrachloride, C-14, Tc-99, and uranium isotopes. In addition, Am-241, I-129, Pu-238, and Pu-239/240 have been detected sporadically at concentrations near detection limits.

The monitoring network has been greatly expanded since 1998 with the addition of 22 vadose zone lysimeters, four upgradient aquifer wells, an aquifer well inside the SDA, and 140 Type A and more than 200 Type B probes in the buried waste. Most of these new installations have not been operational long enough to provide data sets sufficient to assess contaminant trends.

The expanded monitoring network will continue to produce data for assessing source release into the vadose zone, contaminant migration through the vadose zone, and potential impacts to the aquifer beneath the SDA. Analyte lists should be reviewed and modified to prioritize analysis COPCs that may be migrating, especially for vadose zone samples where sample volumes are consistently small.

7.1.2 Contaminant Fate and Transport

Modeling was conducted to simulate release and migration of contaminants from waste buried in the SDA and estimate future contaminant concentrations in environmental media. The details of the modeling are presented in Section 5. Models implemented for the ABRA were the same as those used in the IRA (Becker et al. 1998) with limited improvements to incorporate data obtained since the IRA. Best-estimate inventories were simulated for a base case. Several sensitivity cases were modeled to evaluate effects of upper-bound inventories and several additional specific parameters on estimated media concentrations and risks.

Section 5 addresses potential routes of contaminant migration and persistence of contaminants, source release and migration, and the methodology for determining rate constants used in the biotic model. Complete exposure pathways defined by the conceptual site model led to three types of models: a source release, a subsurface transport, and a biotic transport. Persistence of contaminants in the environment was evaluated based on contaminant mobility controlled by dissolved-phase transport and biotic transfer by animals and plants intruding into the waste. For radioactive COPCs, half-lives also were considered. Chemical degradation was not assessed.

The source term model, simulated release of contaminants from buried waste into the subsurface. Best-estimate source term inventories were used for the base case. The DUST-MS code was used to simulate releases of COPCs and their long-lived decay chain products. Simulated mass release mechanisms comprised surface washoff, diffusion, and dissolution. Release mechanisms were identified based on waste-stream-specific data. Once released, contaminant mass was available for biotic transport to the surface or migration into the subsurface. Sample data for the shallow subsurface from areas around the SDA were not representative of concentrations beneath the waste and, therefore, were not useful for calibrating the source term model. Indirect, limited model calibration was achieved by comparing measured to simulated aquifer concentrations.

Fate and transport of dissolved-phase contaminants in the SDA subsurface were modeled with the TETRAD simulator. Vapor-phase transport for VOCs and other vapor-phase contaminants such as C-14 was not specifically modeled. Model calibration beyond the limited calibration achieved in the IRA was not attempted because of the lack of calibration targets provided by monitoring data. In other words, contaminants of particular interest for model calibration, such as C-14, uranium, and other actinides, are detected sporadically and at very low concentrations that do not describe migration trends. Low concentrations, coupled with lack of trends, are not adequate calibration targets and cannot be emulated with any confidence. A comparison of predicted to detected COPC concentrations in groundwater is presented in Section 5. However, the limited number of detections and low concentrations preclude reaching conclusions about the adequacy of model calibrations. Aquifer concentrations were simulated until peak aquifer concentrations occurred or to a maximum of 10,000 years.

The DOSTOMAN code was used to estimate surface soil concentrations produced by transport of Contaminants to the surface by plants and animals. Rate constants and other input parameters used in the code were selected from current literature, giving preference to site-specific values for the SDA and the INEEL when available. However, surface soil monitoring data were too sparse to calibrate the biotic model, allowing only limited comparisons to measured surface soil concentrations. Further calibration for the biotic model was not pursued because of the fundamental assumption for this ABRA that future remedial action at the SDA will include a cap that would inhibit biotic uptake (DOE-ID 1998). The DOSTOMAN model soil concentrations were estimated for the current time frame and for future human health and ecological exposure scenarios.

7.1.3 Baseline Risk Assessment

Human health and ecological risk assessments are summarized below.

7.1.3.1 Human Health Baseline Risk Assessment. The ABRA addressed the potential risk to human health from contaminants buried in the SDA. Based on EPA and INEEL guidance (EPA 1988; LMITCO 1995), WAG 7 was considered in a comprehensive manner by evaluating cumulative, simultaneous risk for all complete exposure pathways for all COPCs. The risk assessment included exposure and toxicity assessments, risk characterization, and limited analysis of sensitivity and uncertainty.

The IRA identified 29 COPCs, 25 radioisotopes and associated decay chain members, and four nonradioactive constituents. The ABRA quantitatively evaluated cumulative effects for the same 25 radioisotopes and nitrates. Risks from VOCs were scaled from the IRA results based on inventory updates for the **RFP** sludge disposals.

Risk estimates were developed for current and future occupational receptors and for current and hypothetical future residential receptors. For the current residential scenario, groundwater ingestion risk at the INEEL boundary was assessed. Surface exposure pathways were not examined for a current

residential exposure because residential development near the RWMC is prohibited by site access restrictions. Future residential exposures were simulated beginning in 2110 to reflect a postulated remediation in 2010 followed by an assumed 100-year institutional control period. Future residential analysis reflects assumptions that a cap and institutional controls would preclude direct access into the waste, but that a location immediately adjacent to the RWMC could be inhabited. Concentrations and risks were simulated out to 1,000 years for all pathways except groundwater ingestion. Groundwater risks were simulated until peak concentrations occurred or to a maximum of 10,000 years.

Carcinogenic risk estimates for the hypothetical future residential exposure scenario exceed 1E-05 for 14 contaminants and a hazard index in excess of 1 is identified for three contaminants. The location of the maximum cumulative risk is near the southeast comer of the SDA. The groundwater ingestion pathway risk is greater than or equal to 1E-04 for seven radioisotopes: C-14, Np-237, Tc-99, U-234, U-235, U-236, and U-238. Strontium-90 exceeds 1E-04 in the crop ingestion pathway. Carbon tetrachloride exceeds 1E-04 for the groundwater ingestion and inhalation exposure pathways. Carcinogenic risks between 1E-05 and 1E-04 were estimated for 1-129, U-233, and methylene chloride for the groundwater ingestion pathway. Risk between 1E-05 and 1E-04 is identified for Nb-94 in the external exposure pathway; and Am-241 in the soil ingestion, inhalation, external exposure, and crop ingestion pathways. The combined hazard index is greater than 2 for nitrates and tetrachloroethylene in the groundwater ingestion pathway. The carbon tetrachloride hazard index is 50, primarily from inhalation and groundwater ingestion exposure pathways. For the remaining COPCs, risk estimates are less than 1E-05 and the hazard indexes are less than 1.

A qualitative uncertainty analysis and limited sensitivity analysis is provided in Section 6. The sensitivity analysis shows the effect on predicted risks to changes in selected model inputs. Sensitivity cases were implemented to address inventory uncertainty, uranium release rate, neptunium release rate, plutonium mobility both by a traditional partitioning approach and by a mobile fraction approach, infiltration uncertainty, B-C interbed gaps, release of Tc-99 from INEEL reactor operations waste, and the influence of subsurface water originating in the spreading areas on contaminant transport beneath the SDA.

7.1.3.2 Ecological Risk Evaluation Summary. The scope of the ecological risk evaluation discussed in Section 6.6 was limited because of the fundamental assumption that the SDA will be covered with a cap (DOE-ID 1998). Current year and 100-year scenarios were evaluated for representative receptors. Contaminant screening was performed to limit evaluation to those contaminants most likely to pose unacceptable risk. Concentrations in surface soil and subsurface intervals were estimated with the DOSTOMAN biotic uptake model. Receptor exposures were evaluated for all WAG 7 radionuclide COPCs and a suite of representative nonradionuclide COPCs. Seven contaminants, Am-241, Pu-239, Pu-240, Sr-90, cadmium, lead, and nitrate, were shown to pose risk greater than screening values to WAG 7 ecological receptors.

Plant uptake and burrowing by animals are not shown to increase current surface soil concentration levels above EBSLs during the next 100 years. However, current and ongoing risk results from the following: (a) toxic exposures for plants with roots reaching surface and subsurface contamination, (b) ingestion exposures for animals eating those plants, (c) external and inhalation exposures for burrowing animals that feed above ground, (d) external, inhalation, and ingestion exposures for below ground feeders, and (e) ingestion exposures for predators preying on animals contaminated on the SDA.

7.2 Conclusions

Human health contaminants of concern (COCs) for OU 7-13/14 are identified in Table 7-1. Contaminants of concern were identified initially based on risk estimates by apply human health criteria of 1E-05 carcinogenic risk and a hazard index greater than or equal to 1. Sixteen human health COCs were identified. In addition, three plutonium isotopes were classified as special case groundwater COCs to acknowledge uncertainties about plutonium mobility in the environment and to reassure stakeholders that risk management decisions for the SDA will be fully protective. Because most plutonium in the SDA is collocated with risk-based COCs that have similar properties, treating plutonium isotopes as COCs will have little effect on analysis of alternatives or on risk management decisions.

Seven ecological COCs were identified based on a hazard quotient in excess of 1 for radionuclides and a hazard quotient of 10 or greater for nonradionuclides (see Table **7-2).** Five of the seven ecological COCs also are human health COCs. Ecological risk can be addressed by actions implemented to reduce human health. Installation of a cap that incorporates a biotic barrier would inhibit plant and animal intrusion into contaminated subsurface soil, protect ecological receptors from long half-lived radionuclides and nonradionuclide contaminants, and reduce human exposures by preventing biotic transport of contamination to the surface.

Table 7-1. Identification of contaminants of concern and 1,000-year peak risk estimates for a hypothetical future residential exposure scenario.

Contaminant	Note	Peak Risk	Year	Peak Hazard Index	Year	Primary 1,000-Year Exposure Pathway
Ac-227		3E-06	3010"	NA[b]	NA	Groundwater ingestion
Am-241		3E-05	2953	NA	NA	Soil ingestion, inhalation, external exposure, and crop ingestion
Am-243	1,3	4E-08	3016	NA	NA	External exposure
C-14	1,4	6E-04	2278	NA	NA	Groundwater ingestion
Cl-36		6E-06	2110	NA	NA	Groundwater ingestion
Cs-137		5E-06	2110	NA	NA	External exposure
I-129	1,3	6E-05	2110	NA	NA	Groundwater ingestion
Nb-94	1,3	8E-05	3010[a]	NA	NA	External exposure (groundwater ingestion)
Np-237	1,4	4E-04	3010[a]	NA	NA	Groundwater ingestion
Pa-231		3E-06	3010[a]	NA	NA	Groundwater ingestion
Pb-210		5E-07	3010[a]	NA	NA	Soil and crop ingestion
Pu-238						
Pu-239	2	1E-09	2286	NA	NA	Soil and crop ingestion
Pu-240	2	2E-06	3010[a]	NA	NA	Soil and crop ingestion
	2	2E-06	3010[a]	NA	NA	Soil and crop ingestion
Ra-226		3E-06	3010[a]	NA	NA	External exposure
Sr-90	1,4	1E-04	2110	NA	NA	Crop ingestion
Tc-99	1,4	4E-04	2110	NA	NA	Groundwater ingestion and crop ingestion
Th-229		4E-07	3010"	NA	NA	Groundwater ingestion
Th-230		7E-07	3010[a]	NA	NA	Groundwater ingestion
Th-232		1E-09	3010[a]	NA	NA	Crop ingestion
U-233	1,3	3E-05	3010"	NA	NA	Groundwater ingestion
U-234	1,4	2E-03	3010[a]	NA	NA	Groundwater ingestion
U-235	1,4	1E-04	2662	NA	NA	Groundwater ingestion
U-236	1,4	1E-04	3010[a]	NA	NA	Groundwater ingestion
U-238	1,4	3E-03	3010[a]	NA	NA	Groundwater ingestion
Carbon tetrachloride	1,5	2E-03[c]	2105	5E+01[c]	2105	Inhalation and groundwater ingestion
Methylene chloride	1,3	2E-05[c]	2185	1E-01[c]	2185	Groundwater ingestion
Nitrates	1,6	NA	NA	1E+00	2120	Groundwater ingestion
Tetrachloroethylene	1,6	NA	1952	1E+00[c]	2137	Groundwater ingestion and dermal exposure to contaminated water

Notes: For toxicological risk, the peak hazard index is given, and for carcinogenic probability, the peak risk is given.
1. Green = the Contaminant is identified as a human health Contaminant of concern based on carcinogenic risk *greater* than 1E-05 or a hazard index greater than or equal to 1 contributing to a cumulative hazard index greater than 2.
2. Brown = plutonium isotopes are classified as spacial case contaminants *of* concern to acknowledge uncertainties about plutonium mobility in the environment and to reassure stakeholders that risk management decisions for the SDA will be fully protective
3. Blue = carcinogenic risk between 1E-05 and 1E-04
4. Red = carcinogenic risk greater than 1E-04
5. Pink = toxicological (noncarcinogenic) hazard index greater than or equal to 1.

a. The peak groundwater concentration does not occur before the end of the 1,000-year simulation period. Groundwater ingestion risks and hazard indices were simulated for the peak concentration occurring within 10,000 years and are not presented in this table.
b. NA = not applicable.
c. The risk estimates were produced by scaling results from the Interim Risk Assessment (IRA) (Becker et al. 1998) based on inventory updates.

Nonradionuclide Contaminant	Hazard Quotient[a] Current Scenario	100-year Scenario	Radionuclide Contaminant	Hazard Quotient[a, b] Current Scenario	100-year Scenario
Cadmium	<1 to <9	<1 to 20	Am-241	<0.1 to 21	0.7 to 41
Lead	<1 to <6	<1 to 20	Pu-239	NA	<0.1 to >1
Nitrate	<1 to >10	< 0.1	Pu-240	NA	<0.1 to >1
			Sr-90	<0.1 to >25	NA

Human health risks for individual radionuclides are illustrated in Figure 7-1 and Figure 7-2 shows total risk attributable to transuranic and nontransuranic COCs. The simulated 100-year institutional control period precluding residential development near the RWMC, is shown on the figures at 2110 for risk at the INEEL boundary. A hypothetical future residential scenario at the SDA was evaluated for after 2110, as shown in the figure. Assumptions for the future residential scenario include the following:

- A home can be constructed immediately adjacent to the RWMC
- Groundwater use is unrestricted
- A cap and long-term institutional controls inhibit direct intrusion into the buried waste.

Contributions of individual radionuclides to cumulative human health risk are indicated in Figure 7-1. Uranium-234 is shown with two lines. Generally, the U-234 line represents risk generated by the U-238 decay chain, primarily posed by RFP waste, whereas the U-234p line indicates risk from the Pu-238 decay chain generated by INEEL reactor operations waste. With exception of Sr-90, all of the radionuclides contribute to groundwater ingestion risk. The same total risk is shown in Figure 7-2, with contributing radionuclides classified as either transuranic or nontransuranic isotopes. Transuranic risk-based COCs are Am-241 and Np-237; the transuranic special case COCs are Pu-238, Pu-239, and Pu-240. All other human health radionuclide COCs are nontransuranic.

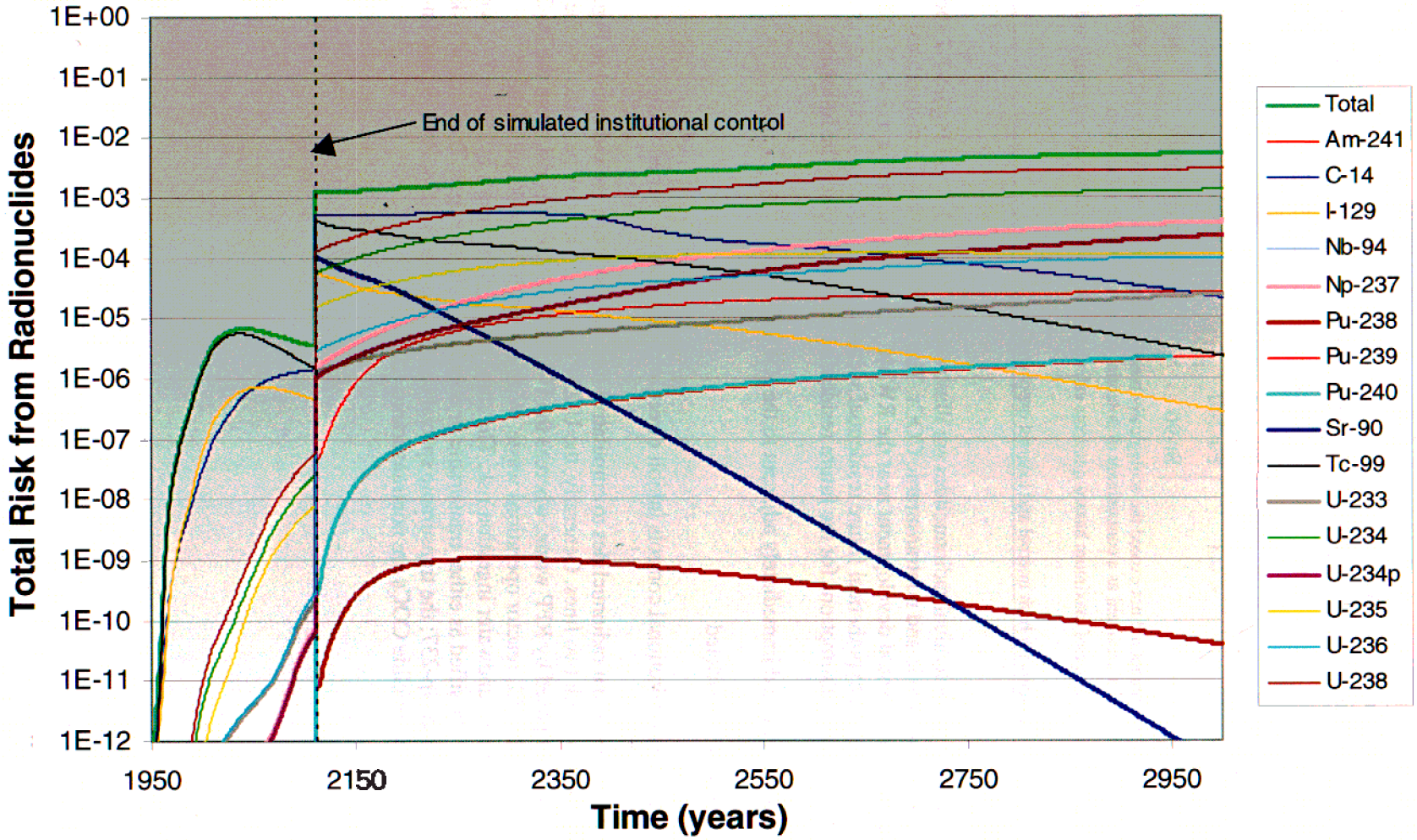

Figure 7-1. Cumulative risk estimates for individual radionuclides for the hypothetical future residential scenario.

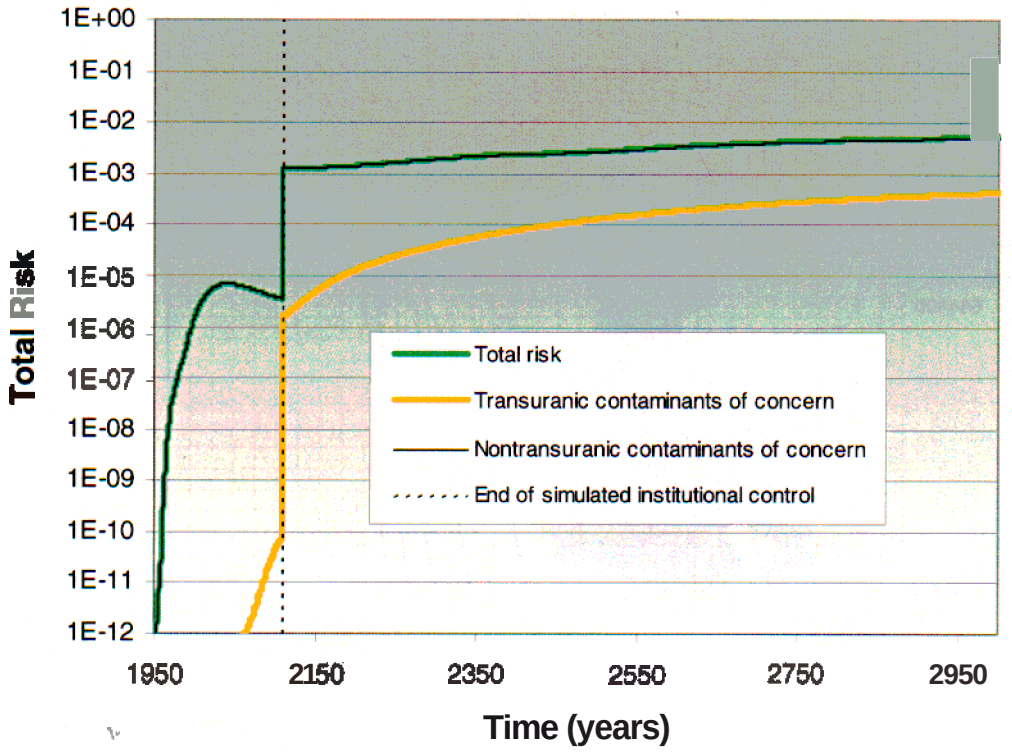

Figure 7-2. Cumulative **risk** estimates for **transuranic and** nontransuranic **contaminants** of **concern** for the hypothetical **future** residential **scenario.**

Mobile long-lived fission **and** activation products pose **the most** imminent **risk,** with actinides driving **the risk far** into **the** future. The **degree** of urgency associated with **risk estimates** for fission and activation products may be **overstated because of release and transport values** implemented in modeling. **However,** C-14, I-129, **and** Tc-99 have been **detected** in **the** environment **and some** trends in **data may** be developing that indicate contaminant **migration.** Presently, **these** contaminants **are** not detected at the levels or frequency predicted **by** the modeling. **Continued** monitoring of locations immediately proximal **to** the waste [in., **Type B probes) is extremely important to assess the** rate **at which the potential** contamination in **the shallow vadose** zone near the **waste** is developing. Interpreting monitoring **data can be used** to validate **the** appropriateness of **an expedited** remediation of **the source** term **to** preclude **this risk.**

Several caveats apply to **risk** estimates, **as follows:**

- **Plots reflect** maximum cumulative groundwater ingestion **risk** anywhere in **the** aquifer for radionuclides. The simulated receptor **location** for this **maximum risk** is **at the southeast corner of the SDA, where the** maximum **estimate occurs.** The **region** of **the** aquifer at that location is not currently **accessible because** of its location within **the** boundaries of tbe INEEL, Modeled cumulative **risk** estimates **at the** INEEL **boundary do not exceed the 1E-05** order of magnitude within **the** simulated **100-year** institutional control period **(see** Figure **7-3)** or the **1E-04 order of magnitude for the peak risk (see** Figure 7-4).

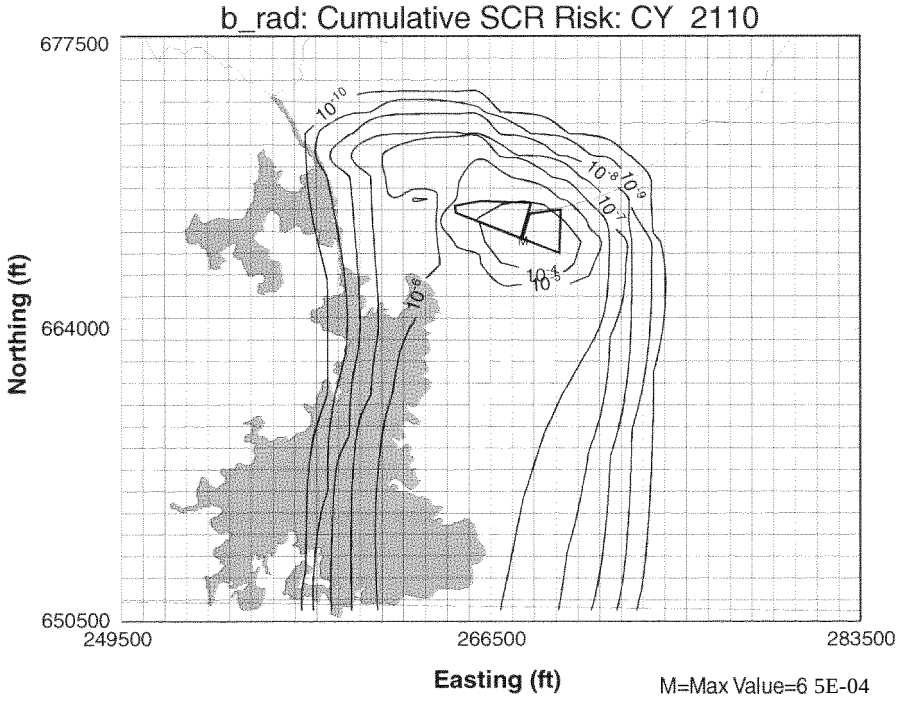

Figure 7-3, Isopleths of cumulative groundwater ingestion risk at the end of the simulated 100-year institutional control period in 2110 for radionuclides.

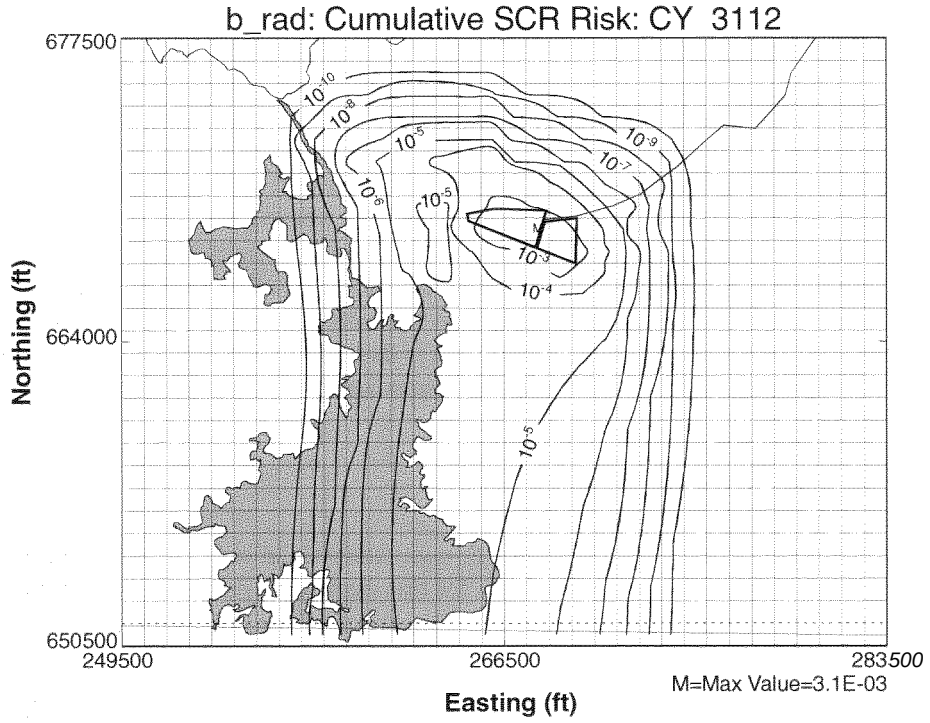

Figure 7-4. Isopleths of peak cumulative groundwater ingestion risk in 3112 for radionuclides.

- The peak cumulative risk, occurring approximately 3112, is primarily attributable to uranium and Np-237. The near-term peak in 2110 is attributable to C-14,I-129, and Tc-99. Substantial uncertainties are associated with estimated risks, and detected concentrations in the environment do not validate the imminent development of the maximum risks. Detected concentrations in the environment are much smaller than the modeled concentrations.

- Some of the detected concentrations in the environment are of the same order of magnitude as the estimated concentrations, and some increasing trends in the monitoring data may be developing. Therefore, the potential vadose zone contamination indicated by the modeling may be developing, but not as quickly as was shown in the simulations. In addition, the magnitude of the peak could be less than currently indicated, but disposal records indicate that the mass of these contaminants in the SDA is enough to predict that their peak risks would still pose unacceptable risks.

- The magnitude of the potential vadose zone contamination depends on the timing of remedial action. If actions to reduce the release of C-14,I-129, and Tc-99 are implemented within the next few years, the potential problem may never develop.

A fundamental assumption in this ABRA is that all remedial alternatives for the SDA will include a cap (DOE-ID 1998). The cap design would be selected to effectively inhibit unacceptable ecological exposures, surface pathway exposures for human receptors, and inadvertent intrusion into the waste. Therefore, remediation of the buried waste should focus on methods to mitigate groundwater exposure pathways. Table 7-3 provides a summary of risk-based and special case groundwater COCs, including the waste streams and their relative contributions to the total inventory for each contaminant. Waste types and disposal locations in the SDA, superimposed on a WasteOScope background, are shown in Figure 7-5. Maps of the locations of the individual human health risk-based and special case COCs are shown Figures 7-6 through 7-17. Produced using WasteOScope, the figures illustrate disposal locations of all of the human health COCs in the SDA as follows:

- Figure 7-6 shows locations of Am-241 and most of the transuranic waste in the SDA. More than 96% of the Am-241 activity in SDA disposals were shipped from RFP in 743-series wastewater sludge. Those disposals are shown in the Trenches 1 through 10, Pits 1 through 12, and on Pad A. Similar, indeterminate disposals are likely located in Trenches 11 through 15 as well. The contribution from INEEL reactor operations, less than 4% of the total, is shown in the other trenches and soil vault rows. While not a groundwater risk driver, Am-241 disposal locations are shown because the majority of the Np-237 is produced through the decay of Am-241.

- Figure 7-7 shows locations of C-14 waste. The C-14 waste originated from INEEL reactor operations. Most of the disposals are in trenches and soil vault rows with the exception of a few scattered shipments in Pits 2, 8, 9, and 10. Because WasteOScope mapping for INEEL waste generators is still in progress, the shipment locations shown in the figure represent a partial data set.

- Figure 7-8 shows locations of 1-129 waste. The 1-129 disposals originated from INEEL reactor operations and are mostly buried in the trenches and soil vault rows. Because WasteOScope mapping for INEEL waste generators is still in progress, the shipment locations shown in the figure represent a partial data set.

- Figure 7-9 shows locations of Nb-94 waste. The Nb-94 disposals are from INEEL waste generators. Most of the Nb-94 was disposed of in trenches or soil vaults with a few scattered disposals in pits. Because WasteOScope mapping for INEEL waste generators is still in progress, the shipment locations shown in the figure represent a partial data set.

- Figure 7-10 shows locations of Np-237 waste. The bulk of the original Np-237 disposals is from INEEL waste generators and is located in trenches and soil vaults. Because WasteOScope mapping for INEEL waste generators is still in progress, the shipment locations shown in the figure represent a partial data set for the initial Np-237 disposals (i.e., excluding ingrowth from Am-241). However, most of the risk-generating Np-237 is produced through decay of Am-241 from RFP (see Figure 7-6).

- Figure 7-11 shows locations of plutonium waste. Most of the Pu-238 is from INEEL waste generators and is located in trenches and soil vaults. Because WasteOScope mapping for INEEL waste generators is still in progress, the shipment locations shown in the figure represent a partial data set. Almost all of the Pu-239 and Pu-240 waste was shipped from RFP. Those disposals are shown in the Trenches 1 through 10, Pits 1 through 12, and on Pad A. Similar, indeterminate disposals are likely located in Trenches 11 through 15 as well.

- Figure 7-12 shows locations of Sr-90 waste. Most of the Sr-90 disposals are from INEEL waste generators and is located in trenches and soil vault rows. Because the WasteOScope mapping for INEEL waste generators is still in progress, the shipment locations shown in the figure represent a partial data set.

- Figure 7-13 shows locations of Tc-99 waste. The Tc-99 disposals are from INEEL waste generators and are mostly in trenches and soil vault rows. Because WasteOScope mapping for INEEL waste generators is still in progress, the shipment locations shown in the figure represent a partial data set.

- Figure 7-14 shows locations of all uranium-bearing waste. Most of the uranium disposals originated from RFP and INEEL reactor operations. Though mapping the RFP waste is complete, WasteOScope mapping for INEEL waste generators is still in progress. Therefore, the shipment locations shown in the figure represent a partial data set.

- Figure 7-15 shows locations of the 743-series organic sludge containing carbon tetrachloride and tetrachloroethylene. These ***COCs*** originated from **RFP** and are located in pits. The disposal locations have been confirmed by shallow soil gas survey data.

- Figure 7-16 shows locations of methylene chloride waste. Most of this chemical is contained in RFP 741-series sludge disposed of in pits.

- Figure 7-17 shows locations of the nitrate salt disposals in the SDA. Approximately 90% of the nitrate was received in nitrate salt waste from RFP. This waste is disposed of in pits and on Pad A.

Table 7-3. Subsurface Disposal Area contaminants of concern for the groundwater ingestion pathway.

Contaminant	Waste Stream Code or Waste Generator	Percent of Total in Waste Stream	Total Inventory (Ci)	Waste Stream Description	Location in the Subsurface Disposal Area
C-14	ANL-785-1	1.5	7.51E+00	Subassembly low-level waste (LLW) from Hot Fuel Examination Facility experiments	
	TRA-603-1H	1.6	7.81E+00	Test Reactor Area (TRA) resins	
	Argonne National Laboratory – West (ANL – W)	3.3	1.66E+01	Subassembly hardware	
	CPP-603-1H	9.2	4.58E+01	Fuel end pieces	
	TRA	18.5	9.26E+01	Beryllium waste	
	NRF-616-3H, 4H, 8H	21.3	1.07E+02	Core structural pieces	
	TRA	41.7	2.08E+02	Activation products	
	Miscellaneous	2.9	1.45E+01	Miscellaneous minor streams	
Total C-14		**100.0**	**5.00E+02**		**See Figure 7-7**
I-129	PBF-620-1	1.2	1.90E-03	Miscellaneous scrap	
	Naval Reactors Facility	1.7	2.67E-03	Test specimens	
	INEEL	94.5	1.49E-01	Idaho National Engineering and Environmental Laboratory (INEEL) reactor operations waste	
Total 1-129		**100.0**	**1.58E-01**		**See Figure 7-8**
Np-237	TRA-632-1H	1.3	3.42E-02	Core structural pieces	
	TRA-603-9H	4.6	1.22E-01	Expended fuel and ceramic fuel	
	TRA-603-4H	6.6	1.74E-01	Core and loop components	
	TRA-642-6H	15.0	3.96E-01	Core, vessel, and loop components	
	TRA-603-1H	15.6	4.13E-01	Resins	
	TRA-603-15H	25.9	6.85E-01	Metal	
	INEEL	28.5	7.54E-01	INEEL reactor operations waste	
	Miscellaneous	2.5	6.61E-02	Miscellaneous minor streams	
Total Np-237		**100.0**	**2.64 E+00**		**See Figure 7-10**

Table 7-3. (continued).

Contaminant	Waste Stream Code or Waste Generator	Percent of Total in Waste Stream	Total Inventory (Ci)	Waste Stream Description	Location in the Subsurface Disposal Area
Pu-238	INEEL	85.3	1.46E+04	INEEL reactor operations waste.	
	Miscellaneous	3.8	6.50E+02	Miscellaneous minor streams.	
	RFO-DOW-9H	2.9	5.00E+02	Noncombustibles—gloveboxes, equipment, pumps, motors, control panels, and office equipment.	
	TRA-603-9H	2.9	4.95E+02	Expended fuel and ceramic fuel.	
	RFO-DOW-3H	1.6	2.75E+02	Uncemented sludge.	
	RFO-DOW-6H	1.4	2.32E+02	Filters.	
	RFO-DOW-12H	1.2	1.99E+02	Dirt, concrete, graphite, ash, and soot.	
	RFO-DOW-4H	1.0	1.74E+02	Combustibles—paper, rags, plastic clothing, cardboard, wood, and polyethylene bottles (Codes 330,336,337,900, and 970).	
Total Pu-238		**100.0**	**1.71E+04**		
Pu-239	RFO-DOW-9H	26.3	1.70E+04	Noncombustibles—gloveboxes, equipment, pumps, motors, control panels, and office equipment.	
	RFO-DOW-3H	14.5	9.40E+03	Uncemented sludge.	
	RFO-DOW-6H	12.2	7.90E+03	Filters.	
	RFO-DOW-12H	10.5	6.79E+03	Dirt, concrete, graphite, ash, and soot.	
	RFO-DOW-4H	9.2	5.96E+03	Combustibles—paper, rags, plastic clothing cardboard, wood, and polyethylene bottles.	
	RFO-DOW-7H	8.3	5.37E+03	Glass—including raschig rings.	
	RFO-DOW-8H	7.0	4.53E+03	Lead from glovebox gloves and sheeting.	
	RFO-DOW-11H	5.2	3.37E+03	Graphite molds.	
	INEEL	2.0	1.29E+03	INEEL reactor operations waste.	
	RFO-DOW-5H	1.9	1.25E+03	Concrete and brick.	
	Miscellaneous	1.9	1.23E+03	Miscellaneous minor streams.	
	RFO-DOW-13H	1.1	7.31E+02	Resins.	
Total Pu-239		**100.0**	**6.48E+04**		

Table 7-3. (continued).

Contaminant	Waste Stream Code or Waste Generator	Percent of Total in Waste Stream	Total Inventory (Ci)	Waste Stream Description	Location in the Subsurface Disposal Area
Pu-240	RFO-DOW-9H	22.5	3.85E+03	Noncombustibles—gloveboxes, equipment, pumps, motors, control panels, and office equipment.	
	INEEL	13.8	2.36E+03	INEEL reactor operations waste.	
	RFO-DOW-3H	12.4	2.12E+03	Uncemented sludge.	
	RFO-DOW-6H	10.4	1.78E+03	Filters.	
	RFO-DOW-12H	9.0	1.53E+03	Dirt, concrete, graphite, ash, and soot.	
	RFO-DOW-4H	7.9	1.35E+03	Combustibles—paper, rags, plastic clothing, cardboard, wood, and polyethylene bottles (Codes 330,336,337,900, and 970).	
	RFO-DOW-7H	7.1	1.21E+03	Glass—including raschig rings.	
	RFO-DOW-8H	6.0	1.02E+03	Lead from glovebox gloves and sheeting.	
	RFO-DOW-11H	4.5	7.62E+02	Graphite molds.	
	OFF-LRL-2H	2.7	4.53E+02	Concrete, bricks, and asphalt.	
	RFO-DOW-5H	1.7	2.82E+02	Concrete and brick.	
	Miscellaneous	2.0	3.42E+02	Miscellaneous.	
Total Pu-240		**100.0**	**1.71E+04**		
Tc-99	D&D-ARA-1	1.1	6.42E-01	LLW from the decontamination and demolition of the Auxiliary Reactor Area facilities (primarily contaminated metal and debris).	
	NRF	2.6	1.56E+00	Test specimens	
	ANL metal	2.9	1.75E+00	Subassembly hardware	
	INEEL	89.9	5.44E+01	INEEL reactor operations waste	
	Miscellaneous	3.5	2.12E+00	Miscellaneous minor streams	
Total Tc-99		**100.0**	**6.05E+01**		**See Figure 7-12**
U-233	SMC-628-1	1.5	2.21E-02	Nonacidic evaporator sludge	**See Figure 7-13**
	SMC-990-1	1.8	2.74E-02	Depleted uranium-contaminated material (metals, glass, and gravel)	

Table 7-3. (continued).

Contaminant	Waste Stream Code or Waste Generator	Percent of Total in Waste Stream	Total Inventory (Ci)	Waste Stream Description	Location in the Subsurface Disposal Area
	SMC-628-2	19.9	3.01E-01	Unsolidified slag	
	RFO-DOW-19H	35.9	5.40E-01	Miscellaneous scrap	
	ARA-626-1H	39.8	6.00E-01	Fuel scrap, waste from disassembly of facilities and hot cell waste	
	Miscellaneous	1.1	1.66E-02	Miscellaneous minor streams	
Total U-233		**100.0**	**1.51E+00**		
U-234	ALE-317-2R	1.1	7.10E-01	Combustibles	
	TRA-603-15H	1.6	1.11E+00	Metal	
	ANL-704-1R	1.8	1.21E+00	Contact-handled fuel fabrication waste	
	OFF-CSM-1H	1.9	1.30E+00	Magnesium fluoride slag and miscellaneous laboratory waste	
	ANL-752-1R	2.0	1.33E+00	Contact-handled waste	
	TAN-607-2	2.7	1.83E+00	Test Area North Hot Shop noncompactable waste	
	OFF-GEC-1H	4.4	2.95E+00	Core, vessel, and loop components	
	ANL-EBRI-1H	5.0	3.36E+00	Miscellaneous combustibles and core, vessel, and loop components	
	OFF-ATI-1H	5.4	3.64E+00	Irradiated fuel from research	
	PDA-IWO-1A	6.9	4.64E+00	Inorganic salts, depleted uranium, and sewage sludge	
	CPP-601-3H	7.0	4.70E+00	Dissolved fuel specimens	
	IWO-DOW-16H	21.5	1.45E+01	Depleted uranium	
	RFO-DOW-18H	31.9	2.15E+01	Enriched uranium	
	Miscellaneous	6.9	4.65E+00	Miscellaneous minor streams	
Total U-234		**100.0**	**6.74E+01**		**See Figure 7-13**
U-235	ANL-752-1R	1.0	5.60E-02	Contact-handled waste	
	OFF-GDA-1H	1.3	7.00E-02	Fuel fabrication item, laboratory equipment, activated metal, and irradiated fuel	

Table 7-3. (continued).

Contaminant	Waste Stream Code or Waste Generator	Percent of Total in Waste Stream	Total Inventory (Ci)	Waste Stream Description	Location in the Subsurface Disposal Area
	OFF-CSM-1H	1.4	8.00E-02	Magnesium fluoride slag and miscellaneous laboratory waste	
	ANL-EBRI-1H	2.0	1.10E-01	Miscellaneous combustibles and core, vessel, and loop components	
	OFF-ATI-1H	2.1	1.14E-01	Irradiated fuel from research	
	INEEL	2.3	1.28E-01	INEEL reactor operations waste	
	CPP-601-3H	2.7	1.50E-01	Dissolved fuel specimens	
	OFF-GEC-1H	2.8	1.57E-01	Core, vessel, and loop components	
	WAG-WG7-02	3.3	1.80E-01	Acid Pit in situ stabilization treatability study	
	PDA-RFO-1A	5.9	3.25E-01	Inorganic salts, depleted uranium, and sewage sludge	
	TRA-603-6H	7.3	4.02E-01	Core, vessel, and loop components	
	TRA-603-15H	9.7	5.35E-01	Metal	
	RFO-DOW-18H	13.4	7.44E-01	Enriched uranium	
	TRA-603-16H	14.1	7.80E-01	Combustibles	
	RFO-DOW-16H	19.5	1.08E+00	Depleted uranium	
	Miscellaneous	11.3	6.26E-01	Miscellaneous minor streams	
Total U-235		**100.0**	**5.54E+00**		**See Figure 7-13**
U-236	SMC-628-2	**1.5**	4.37E-02	Unsolidified slag	See **Figure 7-13**
	NRF	1.8	5.29E-02	Test specimens	
	RFO-DOW-18H	2.8	8.04E-02	Enriched uranium	
	TRA-603-9H	2.8	8.11E-02	Expended fuel and ceramic fuel	
	TRA-603-4H	3.7	1.07E-01	Core and loop components	
	TRA-642-6H	8.5	2.44E-01	Core, vessel, and loop components	
	TRA-603-1H	9.4	2.70E-01	Resins	
	TRA-603-15H	14.7	4.22E-01	Metal	
	INEEL	20.4	5.83E-01	INEEL reactor operations waste	
	RFO-DOW-16H	31.5	9.03E-01	Depleted uranium	

Table 7-3. (continued).

Contaminant	Waste Stream Code or Waste Generator	Percent of Total in Waste Stream	Total Inventory (Ci)	Waste Stream Description	Location in the Subsurface Disposal Area
	Miscellaneous	2.6	7.44E-02	Miscellaneous minor streams	
Total U-236		**100.0**	**2.86E+00**		
U-238	INEEL	1.1	1.30E+00	INEEL reactor operations waste	
	ALE-ALE-1H	1.1	1.32E+00	Building rubble, electric wires, piping, machinery, tracers and sources, glass, gloves, paper, filters, and vermiculite	
	OFF-CSM-1H	1.1	1.32E+00	Magnesium fluoride slag and miscellaneous laboratory waste	
	ARA-627-1H	1.4	1.64E+00	Fuel scrap, waste from disassembly of facilities, and hot cell waste	
	SMC-628-2	2.0	2.31E+00	Unsolidified slag	
	PDA-RFO-1A	21.2	2.49E+01	Inorganic salts, depleted uranium, and sewage sludge	
	RFO-DOW-16H	65.0	7.62E+01	Depleted uranium	
	Miscellaneous	7.0	8.20E+00	Miscellaneous minor streams	
Total U-238		**100.0**	**1.17E+02**		**See Figure 7-13**

Contaminant	Waste Stream Code or Waste Generator	Percent of Total in Waste Stream	Total Inventory (g)	Waste Stream Description	Location in the Subsurface Disposal Area
Carbon tetrachloride	RFO-DOW-4H	2.5	2.05E+07	Paper, rags, and plastic	
	RFO-DOW-15H	96.8	7.94E+08	Organic sludge	
	Miscellaneous	0.7	5.74E+06	Miscellaneous minor streams	
Total carbon tetrachloride		**100.0**	8.20E+08		**See Figure 7-14**
Methylene chloride	RFO-DOW-12H	9.3	1.30E+06	Dirt, sand, concrete, ashes, and soot	**See Figure 7-15**
	RFO-DOW-9H	18.3	2.56E+06	Equipment (drill presses, lathes, and pumps)	
	RFO-DOW-4H	20.3	2.84E+06	Paper, rags, and plastic	

Table 7-3. (continued).

Contaminant	Waste Stream Code or Waste Generator	Percent of Total in Waste Stream	Total Inventory (g)	Waste Stream Description	Location in the Subsurface Disposal Area
	RFO-DOW-3H	51.2	7.16E+06	Uncemented sludge	
	Miscellaneous	1.0	1.40E+05	Miscellaneous minor streams	
Total methylene chloride		**100.0**	**1.40E+07**		
Nitrate	CPP-601-4H	11.0	1.13E+08	Acidic aqueous liquid	
	PDA-RFO-1A	**53.0**	5.46E+08	Nitrate salts Rocky Flats Plant (RFP) sludge	
	RFO-DOW-17H	36.0	3.71E+08	Nitrate salts in sludge	
Total Nitrate (as nitrogen)		100.0	1.03E+09		**See Figure 7-16**
Tetrachloroethylene	RFO-DOW-15H	100.0	9.80E+07	Organic sludge	
Total tetrachloroethylene		100.0	9.80E+07		**See Figure 7-14**

Figure 7-5. Waste types and disposal locations in the Subsurface Disposal Area.

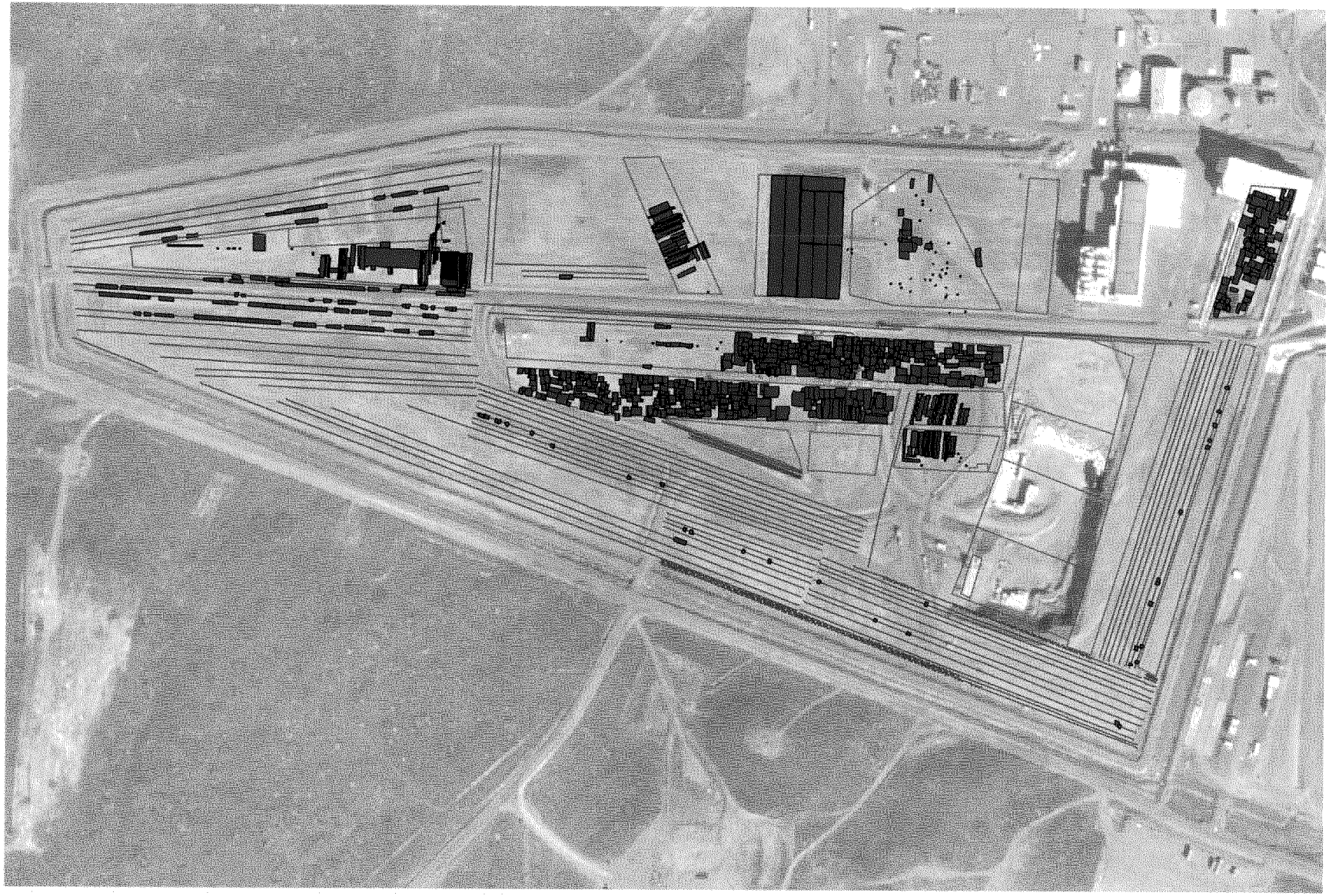

Figure 7-6. Americium-241 disposal locations in the Subsurface Disposal Area.

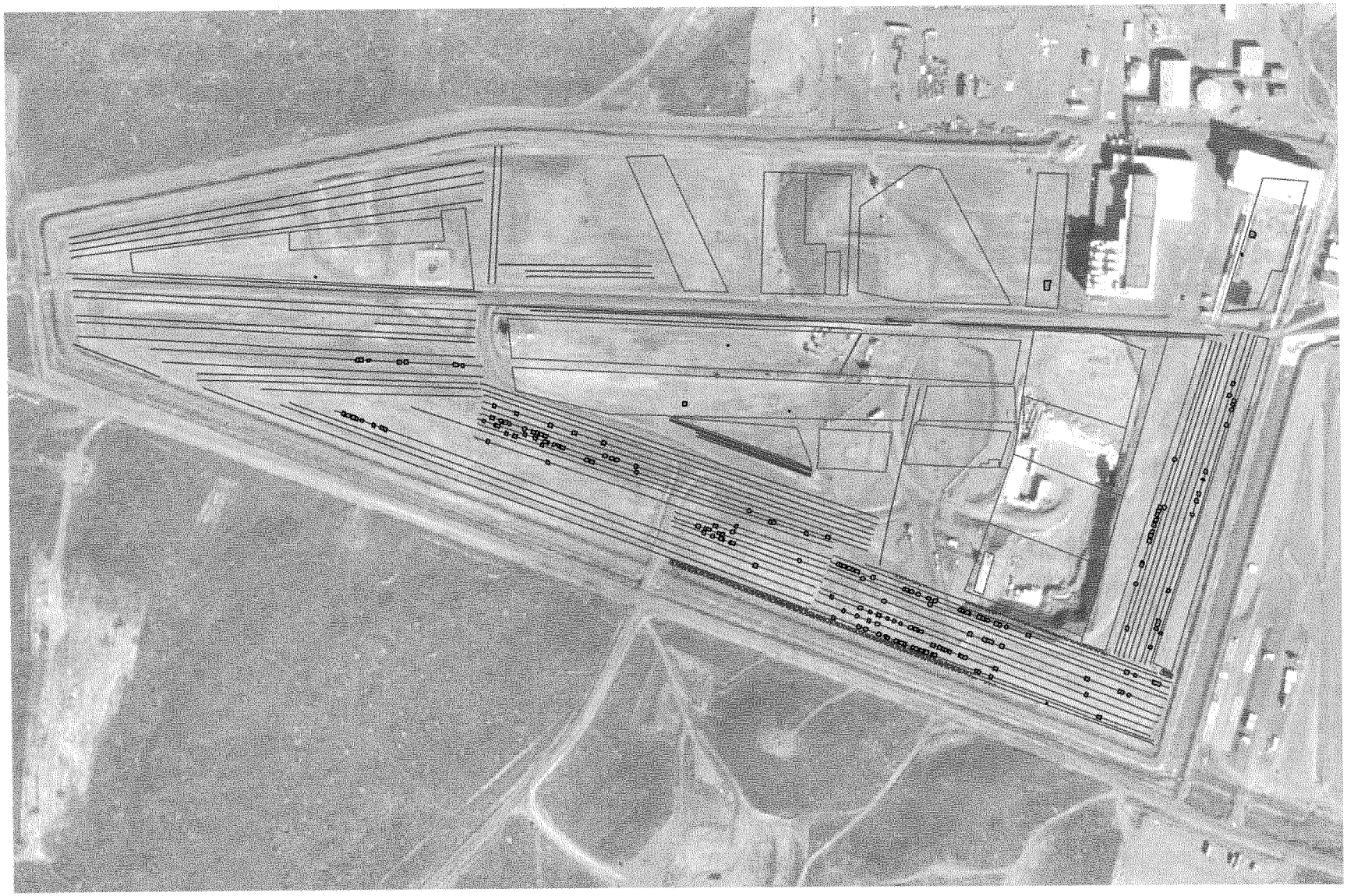

Figure 7-7. Carbon-14 disposal locations in the Subsurface Disposal Area based on a partial mapping data set.